RESEARCH ARTICLE

Energy Conservation in Office Environment

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ABSTRACT: The present energy consumption situation initiates top priority for energy management and effective utilization of generated electrical power. It is studied that more than 40% of the total electrical power generated is wasted due to improper consumption or monitoring. As observed in most of the offices most of the electrical appliances like fan, lights will be left ON from day break to evening even if the personnel's are not present. As a result a huge amount of energy is wasted. Moreover the need ensuring security is becoming very vital in our day-to-day life. It is necessary to ensure security in offices, factories, banks, confidential areas of research centres and power plants etc. But now in these areas the task of maintaining security has become an enormous technological challenge. The current work mainly concentrates and safe guard against unauthorised entry using GSM module, fire sensing circuits and efficient energy usage by automatic control of fan, office lights, surrounding light illumination and garden water pump control. The office management system is a Novell network which considers the above concepts and monitors inefficient use of electrical energy using embedded systems. The expected outcomes of present work are namely, save energy and display energy data on LCD unit, provide better infrastructure, saving energy and smart operation for basic tasks. Office employees become more flexible and increases public relations, improve and alters the quality of work leading to the workers job satisfaction.

KEYWORDS: Energy conservation, Smart office, Office control, GSM based office security

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1. INTRODUCTION

People spend a lot of time in offices. Office environment directly affects the working efficiency of the employees. So comfort is needed in office. The present work focuses on control of electrical apparatus and energy conservation opportunities in office environment considering safety. A smart office is a place that makes life easy for employees and it increases their ability to stay connected through by making use of various advanced technology and different tools and solutions to improve the efficiency of users. As the physical boundaries are being bridged, a complex and competitive word focuses on innovation and creativity is being developed. The world is highly experiencing the emergence of intelligent growth zones so smart office has fast become the need of the hour. A smart office is the one that ensures the optimal and effective utilization of physical infrastructure and IT resources. In other words, offices in today's generation of information technology are automated. There is need for technological advancement environment which is very transparent. The effective advanced automation, use of various communication tools in the system shows the positive impact on the business and growth of company or any organization over a period of time. It also increases the productivity through enhanced communications among team members which affects in the output. A smart office is to be designed with one thing in mind to release full potential of workforce. It's not rocket science just innovative thinking and new technology that best fits people's needs. Office automation among other things facilitates easy documentation and real time communication. The effective automation or use of communication tools in the output of an organization that showcases the positive impact on the bottom line over a period of time. To conserve the energy in office and industry sector we are using natural light sensor and temperature sensor with suitable drive circuit to operate the motor to open and close the curtains and also to operate the fan and AC automatically. To safeguard the office and industry we are using different safety sensor which are interfaced to microcontroller to GSM modem to send the alert message and to control the main door with authentication person. And also there is automation for garden management and lighting control using the same technology. Existing building architectures consumes large amount of energy. Significant amount of energy can be saved by managing the electric consumption in commercial buildings. Because of these issues, the concept of smart office emerges. For industrialization and globalization there is a rapid growth found in every field and increasing a demand of automation in office, home and industries. The existing methods for automation needs either need more man power and not precision.

Office automation is best tool to achieve proper ways to save time and optimum use of time in organization. Office automation is mechanism to enhance productivity of organization by effective management and use of electronic based data circulation in the organization. For usage and proper control on environment and classified information accuracy in doing works [1-3]. By referring

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many of the IEEE papers and journal papers, few research papers which served as the basic idea and provided the platform to implement certain applications which helps in advancement of office environment. A smart office automation system usually consists of an embedded automation system, several controlled objects like op-amp, LDR sensors, and corresponding sensors which are sensitive to user's demand. On the aspect of controlled objects, recent researches put focus mainly on light control. And certain methods for lighting control with wireless sensor and actuator networks. Moreover, smart office should also record user's preference and carry out dynamic adjustment in view of the last ten times emend of the user. What exact illumination and day light is needed by the office members should be known and implemented wisely according to the needs [4-6]. The safety services provided through automation focuses on security enhancements. The references provide the frame work to go real time decision and implement a domestic safety feature i.e fire detector which is one of the various features stand point in advancements in office automation. This feature is implemented using user interface, monitor that can give orders to control systems. Modes of transmissions are like ether net or wireless equipment devices like radio waves, infrared, blue tooth GSM module. Central controller i.e. hardware interface by controlling office services [7].

Based on survey study microcontroller, user interface, a communication interface and their performance factor, by acquiring the knowledge of DIY i.e. do it yourself platforms after working hours the lights surrounding are also controlled by using GSM module and certain written codes are simply executed without any obstacle[8]. The smart office addition service consists of information systems and services, communication and collaboration system and services, personal assistance, office management systems and services. Goals of office environment are comfort gain, energy efficiency, cost optimization, security enhancement, service optimization, increase of guest satisfaction. The information technology market involved in automation system provides commercial solutions which are addressed to the comfort, the reduction of energy consumption and the cost saving and electric device used very user friendly and easily controlled and monitored using available methods [9]. Based on this, the method implementing here uses electronic methods to make automation as well as smart power saving concept also. We are using GSM technology with different sensor technique.

2. IMPLEMENTATION AND WORKING

The need of ensuring energy conservation and energy efficiency have become very crucial hence it is necessary to limit the consumption of energy, to achieve this we have made an attempt to minimize the unnecessary usage of power by implementing automation. The proposed work makes use of different electronic circuit, a microcontroller and mobile communication for its appropriate functioning to meet the defined objective. The overall block diagram is as shown in Fig 1 and the same depicts the expected inter connections.

The Fig 1 uses circuits like fire detection, illumination control of cabin, automatic fan control, open/close of window and curtain, GSM interface to open and close cabin door and garden water pump. LCD display unit display status of fan and lamp, status of availability of person in cabin and Energy usage. Fig 2 through Fig 8 shows the images of practical implementation of the concept. Cabin light controlling is done through natural light sensor whose output is compared with the reference based on the lumens requirement the curtains and LED lights are controlled.

Fig 4 and Fig 5 show the practical circuits used for the same. Automatic fan control, window open and close controlling is done using temperature reference taken from the thermistor installed in the cabin. Operation of window and fan takes place through relay switching circuit. Garden water pump switching circuit as shown in Fig 7 employs moisture sensor whose output is compared with the preset moisture level of the campus garden and on requirement the pump is made ON. The GSM unit is interfaced and gets connected to campus lighting, automatic open/close of cabin door using SMS (short messaging service) and Fire sensing unit. LCD unit displays status and the total energy consumption by the end of the day as shown in Fig 5.

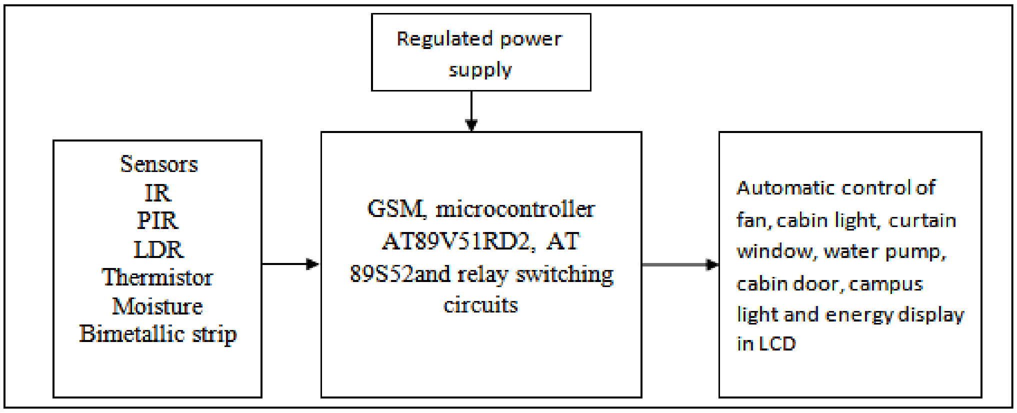
Regulated power supply
Sensors
IR
PIR
LDR
Thermistor
Moisture
Bimetallic strip
GSM, microcontroller AT89V51RD2, AT 89S52and relay switching circuits
Automatic control of fan, cabin light, curtain window, water pump, cabin door, campus light and energy display in LCD

Fig 1 Overall block diagram

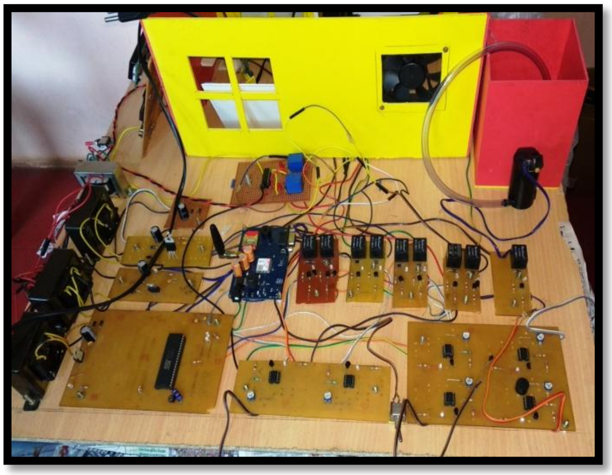

Fig 2 over all view of energy conservation

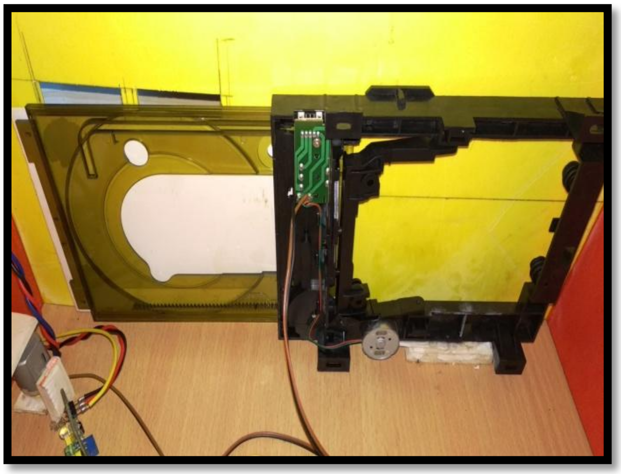

Fig 3 Curtain open and close in office

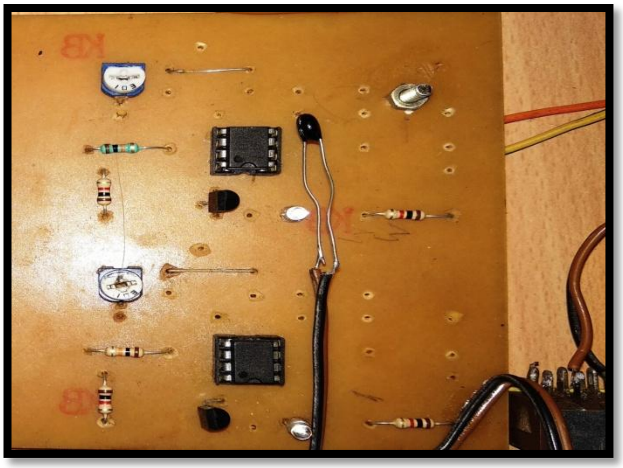

Fig 4 Room Light control

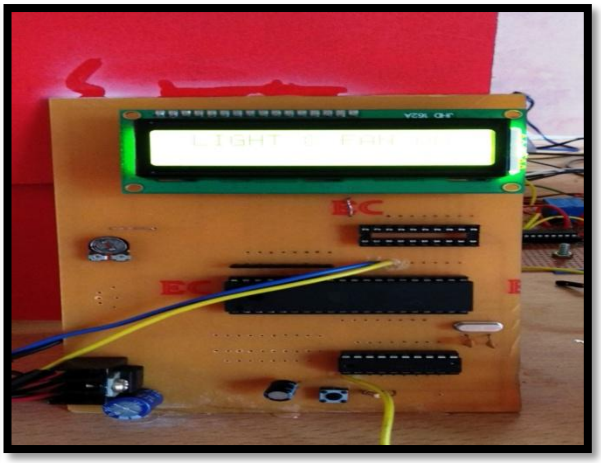

Fig 5 LCD Unit interface

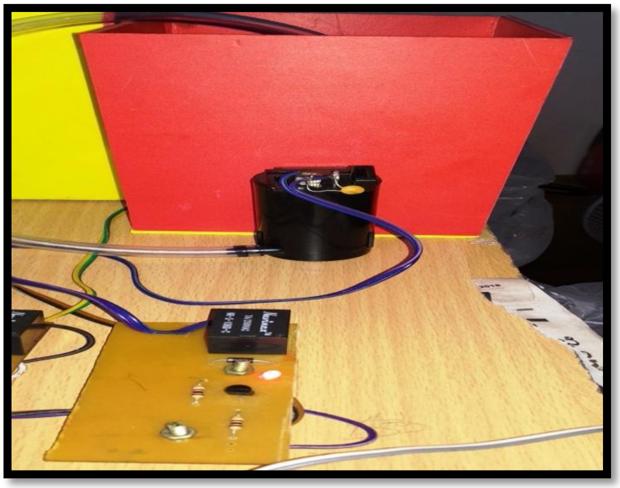

Fig 6 Garden pump control

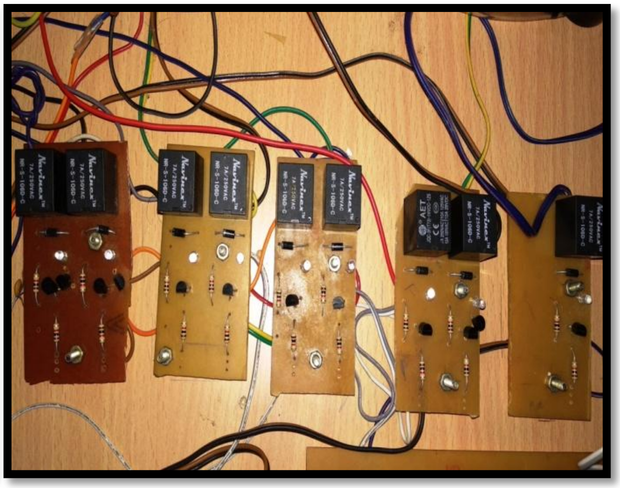

Fig 7 Relay board circuit control

3. DIFFERENT CIRCUITS USED

3.1 Cabin light control

To have proper illumination during working hours depending upon the illumination of sunlight, the office or cabin illumination and curtain open and close is controlled by using LM358 comparator. Fig 8 shows a typical circuit for the purpose.

3.2 Fire sensing circuit

Controlling fire in office involves lot of risk and the system designed can serve for the purpose of monitoring and controlling the fire. The Fig 9 shows the same. Room Light control and fire sensing is possible by various practical methods. Here we are using bimetallic strips with a comparator, which is placed in the office. The bimetallic strips which are normally open and as soon as the temperature across plates rises, heat developed across the strips comes in contact and is converted back in terms of potential difference. pin 2 of op amp comparator is given to preset value set by resistor pot and pin 3 is given to output of fire sensor value , after comparing these two values if the value is above the preset value, the logical o/p goes high and the output pin1 of comparator given to alarm which goes high and mean while sends signal to microcontrollers pin 1.1 which reads and sends an alert message through RX and TX pin (PIN 11 and 10 respectively) of controller to GSM and the message is conveyed to FIRE department and one message to manager.

3.3 Cabin light control

A light sensing circuit is designed with LDR, OP_AMP and Transistor. The LDR (Light Depended Resistor) is used as a light sensitive resistor. The LDR resistance is very high under dark conditions and low under bright conditions. Here the OP_AMP is used as a voltage comparator and under normal (Dark) condition the LDR resistance is very high. So the voltage at Pin is less than the Reference Voltage. As soon as light (More light) falls on the LDR, its resistance decreases which increases the voltage at non-inverting terminal of the OP_AMP. Because of this condition the potential difference between two inputs at comparator also changes and the output of the comparator goes from its low to high state to activate (Saturate) base terminal of the transistor which is used as switching circuit as shown in Fig 10. Thus from emitter to collector current flows and turns ON/OFF of light only when PIR motion detective sensor give high value (person is present in the cabin). Similarly another comparator is used for open and closing of curtain for the light illumination. Comparator goes high when LDR sensed value crosses the reference value which set in pot. The output of comparator is given to switching circuit base terminal of the transistor and thus current starts flowing from emitter to collector which activates the relay, a relay unit as shown in Fig 11 consists of relays which is used for bidirectional operation of motor (clock wise /anti clock wise) to open and closing of curtain. From mobile the message is sent to turn ON/OFF of lights to GSM module which is interfaced with microcontroller pin 38 and pin39 of 89V51RD2 microcontroller then the lights are turned ON/OFF. The light ON/OFF status is sent back to operator mobile.

3.4 Automatic open/close of door using GSM

To keep data and files confidential, security is provided for automatic open and close of the cabin door by authenticated person through GSM module. From the authenticated person's mobile the message is sent to open/close the door to GSM module which is interfaced with microcontroller pin 38 and pin 39 of 89V51RD2 microcontroller. Output of the controller is given to relay unit via switching circuit consisting of transistor and freewheeling diode, which operates motor in bidirectional that is clockwise and anti clockwise in order to open and close of door.

3.5 Automatic fan control, window open and close

The room temperature is controlled by open/close of window and turning ON/OFF fan depending on the temperature sensed by thermistor. Here two LM358 comparators are used one is for the operation of window control and the other for operation of fan. In which pin 2 of first comparator is given to window preset value similarly pin 2 of second comparator is given to fan preset value, pin 3 of both comparator is given to output of thermistor. Over here a low preset value is set for windows to open/close and high preset value is set for fan to ON/OFF by resistor pot. If the temperature exceeds low preset value then window will be opened and it closes when it goes below preset value. Similarly if at all temperature exceeds higher preset value than fan turns ON/OFF via relay switching circuit.

3.6 Energy usage display

The energy usage display is done through LCD display where the energy usage and appliances commands are displayed. The display LCD used is 16×2 which will display the 32 characters at a time in two rows (16 characters in one row). when the door opens "WELCOME" message is displayed on the LCD and when fan and lamp appliances are turned ON then the respective status of the appliances are displayed and also their energy consumed in units is displayed and after continuous running of the appliances, by the end of the day the total energy consumed in units is displayed and when the authenticated person is not available in the cabin the message gets displayed on the LCD informing that the person is not available in the cabin and his/her proper schedule of arrival will be displayed.

3.7 Working of the model

A situation must be understood that when a person enters the cabin by messaging ON1 using registered mobile. The door is opened and a welcome message is displayed on the LCD display. When authenticated person enters the room his/her presence is sensed by PIR and IR sensors, fan and lights are turned ON and they are controlled by LDR and thermistor. Depending upon the sunlight and air circulation inside the room the window

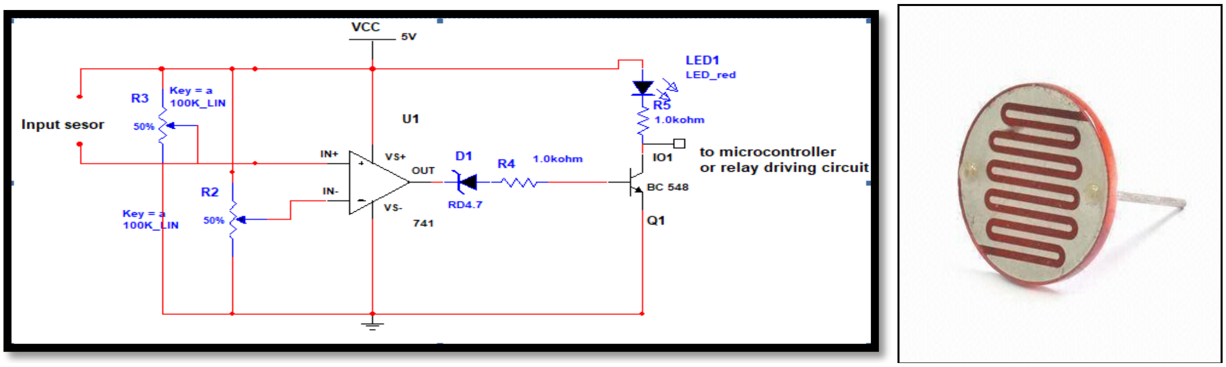

Fig 8 Cabin illumination control circuit and LDR

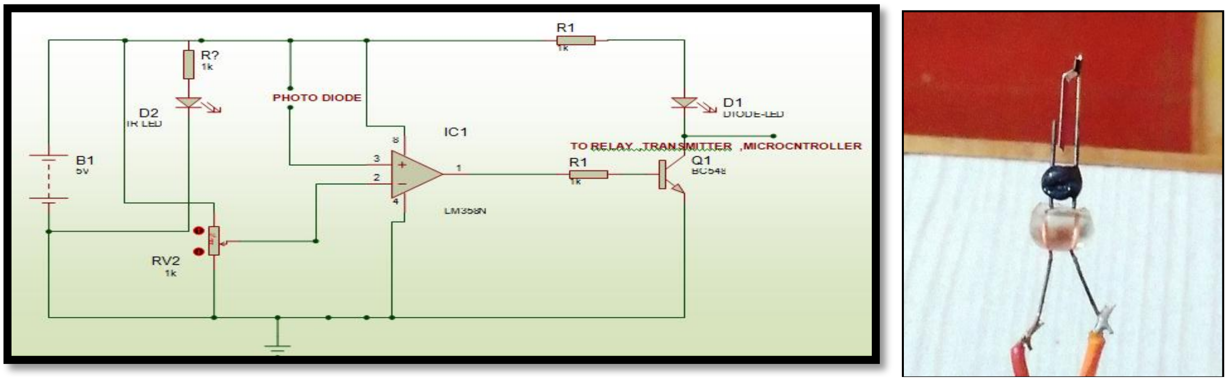

Fig 9 Fire sensing circuit and Bimetallic strip

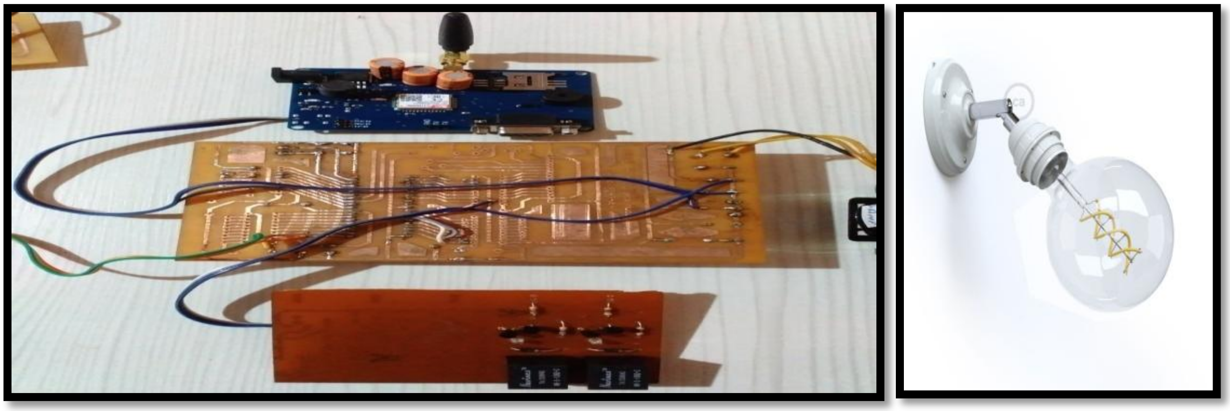

Fig 10 Campus lighting and typical lamp

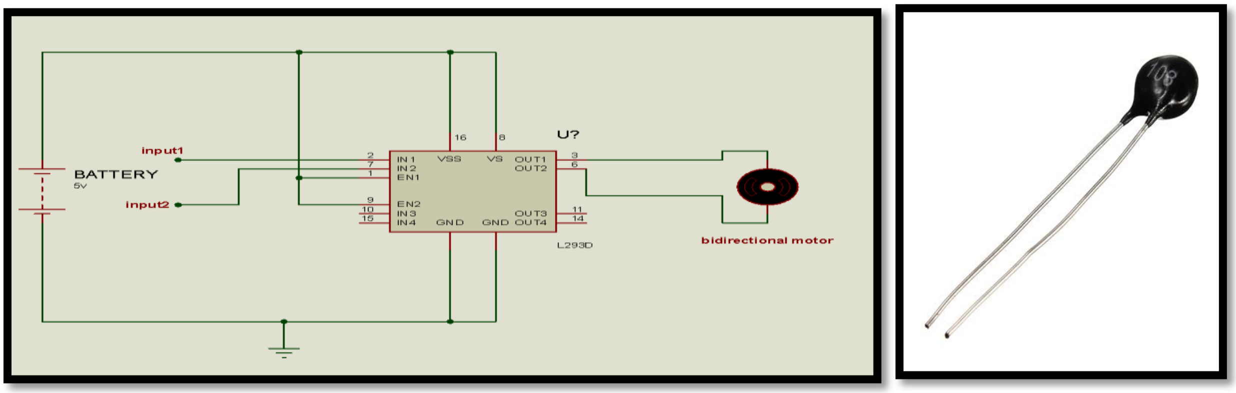

Fig 11 Bidirectional motor drive circuit and a Thermistor

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and curtains are operated. After working hours of the office the energy consumed is displayed on the LCD. When he/she comes out of the cabin or the absence is traced, the fan and lights are turned OFF through GSM by messaging OFF1. Similarly, consider a situation of fire hazard occurs in campus and which will be detected by fire sensor and immediately through GSM module messages are sent to manager of the office and to the fire extinguish department. A warning or alert alarm in the campus is also enabled.

4. RESULTS AND DISCUSSION

In present work several applications have been implemented namely, automatic fan control, window open/close control, room illumination control, curtain open/close operation and automatic water pump control, fire sensing circuit, campus lighting and energy usage display through LCD. From all above implemented applications and case study a saving of minimum of 20% of energy units is noticed. Considering the KLEIT college administration office environment as a sample input to our work an analysis was made. The ratings of equipments and energy consumption is tabulated and studied. The Table1 and Table 2 provide the data analysis of energy usage of an office environment before and after implementing the above mentioned applications.

The Tables shown above use the respective ratings and quantities, average working hours, units consumed by appliances in all the three seasons per annum and then the total cost is calculated. After implementing the proposed concept in the office there is a visible difference in the units consumed before and after implementation which is the point of concern since it is sure to conserve the energy and reduce the electricity cost. From the above two tables an average of 20-25% of saving in consumed energy is obtained hence automation is really needful and essential.

Table 1 Comparative study before implementation seasonally

Sl.No	Appliances	Rating (Watts)	Quantity	Summer season Hours/day	Rainy/ Winter Hours/day	Total units in Summer	Total Units in Rainy/ Winter
1	Ceiling Fan	60	22	7	2	9.24	2.64
2	Spiral CFL POP bulb set	24 22	30 4	3.5 3.5	5 5	2.52 0.31	3.60 0.44
3	Batten T5	24 20	10 12	3 3	4.5 4.5	0.72 0.72	1.08 1.08
4	Printers	75	8	4	4	2.4	2.4
5	Desktop computer	80	9	7	7	5.04	5.04
6	Air conditioner	2000	4	4	1	32	8
					Total	52.95KWh	24.28KWh
					Total cost (Rs)	391.81	179.67

Table 2 Comparative studies after implementation seasonally

Sl.No	Appliances	Rating (Watts)	Quantity	Summer season Hours/day	Rainy/ Winter Hours/day	Total units in Summer	Total Units in Rainy/ Winter
1	Ceiling Fan	60	22	3	1	3.96	1.32
2	LED bulb	10	34	2.5	5	0.85	1.70
3	Tube light set	22	22	2.5	5	1.21	2.42
4	Printers	75	8	4	4	2.4	2.4
5	Desktop computer	80	9	7	7	5.04	5.04
6	Air conditioner	2000	4	2.5	1	20	8
					Total	33.46KWh	20.88KWh
					Total cost (Rs)	247.60	154.51

5. CONCLUSION

The implemented work using microcontroller and added electronic circuits found working as expected. The security and energy saving was well noticed and was tabulated for the comparative study. The devices were controlled by sending an SMS and the alerts were received as an SMS in return as well. A temperature sensor, fire detection and light control were very useful in achieving the success in the work. SIM900 GSM module was interfaced with 89V51RD2 µC for the communication between the µC unit and the user mobile. The developed GSM based security system exhibited good performance. Flexibility with the technical customization and economy are the main advantages of the design. In future works as a scope for improvement, light intensity can be varied based on the sun light intensity, fan speed can be controlled and more sensors can be integrated for making it increasingly skilled and intelligent.

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